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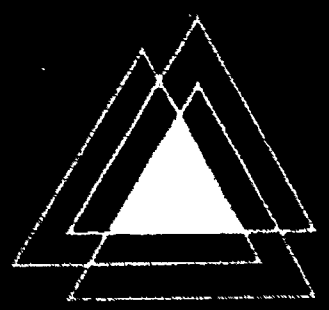
ABSTRACT

During the past decade, organizations and individuals in communities across the United States have come together in alliances to promote the improvement and reform of science, mathematics, and technology education in elementary and secondary schools. This handbook draws from the experiences of those pioneer local alliances to provide insights and practical guidance for others who want to help schools and students, but don't know where to begin. Topics of discussion include: (1) a rationale for building alliances; (2) anatomy of an alliance; (3) identifying leadership and recruiting partners; (4) steps to building consensus; (5) key components of successful alliances; (6) action and implementation; and (7) organization of alliances. A description of the Triangle Coalition, a list of the major organizations that assist alliances, a list of academic alliances, a checklist of whom to involve in alliances, principles for building and maintaining alliances, examples of alliance programs, and a chronological summary of selected reports dealing with the issue of educational reform are appended. (KR)

A GUIDE FOR BUILDING AN ALLIANCE FOR SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

An alliance is a coalition of interested institutions and groups working together to promote the improvement and reform of science, mathematics and technology education.



PREFACE

The Triangle Coalition for Science and Technology Education's involvement with alliance building and sustenance dates back to the National Conference on Local Alliances for Science and Technology Education held at Wingspread in the summer of 1985. Since that conference, the Triangle Coalition has been funded by the Carnegie Corporation of New York to work with existing alliances and to help form new ones. It has emerged as an informal umbrella organization for the alliance movement in science, mathematics and technology education. For more information on the Triangle Coalition see Appendix 1.

At that first Wingspread conference, we knew of 60 alliances nationwide. Our database now shows over 500. Many of the alliances listed in the database were formed with the assistance of the Triangle Coalition and midwifed by the first edition of our handbook, *How to Form and Operate a Local Alliance.*

That first edition, partially funded by both the Carnegie Corporation of New York and the National Science Foundation (NSF), was broadly distributed. Some 5,000 copies went out to help establish these local bases for science education reform. We expect this revised edition, which is partially funded by the Carnegie Corporation, to be as popular and useful as the original one.

Collaborating with alliances, getting them started and helping them become agents of reform, has always been a major thrust of the Triangle Coalition. Our projects, the National School Volunteer Project in Science, Mathematics and Technology; the Summer Industrial Fellowships for Teachers project; and the technical assistance and networking endeavor that we are undertaking for the Department of Education, are all focused locally through alliances. These projects not only are examples of activities that an alliance can undertake, but also can, if begun independently, serve as nuclei for the formation of an alliance.

The Triangle Coalition, of course, has no patent on the alliance movement, and during the past few years many other organizations have recognized the importance of contact with broad-based groups at the local and state levels. Many organizations have begun to build alliances or to work through existing alliances to achieve internal goals. We hope that this new guide will prove useful to them and their alliances, as well as to others. The Triangle Coalition looks forward to working with alliances and other organizations toward our common goals.

John M. Fowler
Executive Director
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TABLE OF CONTENTS

INTRODUCTION

During the past decade, organizations and individuals in communities across the United States have come together in alliances to promote the improvement and reform of science, mathematics, and technology education in elementary and secondary schools. A strength of these alliances is that they are broad-based.

This handbook draws from the experiences of those pioneer local alliances to provide insights and practical guidance for others who want to help schools and students, but don't know where to begin. It is intended not to be a model, but a stimulus and a comforting presence for those embarking on the new adventure of alliance building. Since 1985, grants from the Carnegie Corporation of New York have enabled the Triangle Coalition to offer a program of services to alliances and to accelerate the network's growth and effectiveness. For more information on the Triangle Coalition see Appendix 1.

The following are points that should be made clear before we begin the discussion:

- What, exactly, is meant by an "alliance"? The words "partnership," "alliance," "collaborative," "coalition," "consortium" and many others can be used to describe the coming together of diverse organizations and individuals, from both the public and private sectors, with a common goal of encouraging and supporting science, mathematics and technology education at the precollege level. We have chosen the word "alliance," but it isn't meant to have a narrow or exclusive connotation. There are several possible kinds of alliances and many of them are described in the appendices to this manual. Whatever they are called, collaborative organizations almost always start with the enthusiasm of an individual or a handful of leaders who want to solve a problem that one institution or group on its own could not solve. Alliances take many forms. Some are local, focused around a city or a school system; others are statewide or regional.

- We believe that it is not possible to reform any part of the education system, including science and technology, in isolation from broader issues of education policy and management. Successful science/technology alliances are aware of and involved in the needs of education as a whole. We also believe that it is not fair or practical to

blame any one sector of society for our educational dilemmas.

- This manual, while focused on alliances for science, mathematics, and technology education, outlines some strategies and principles for cooperation that can be transferred to other subjects in the school curriculum. However, we strongly suggest that any alliance proposing to broker education initiatives should be composed of partners who have expertise in the specific curriculum areas being addressed.

I. RATIONALE FOR BUILDING ALLIANCES

Education is everyone's business. A society's level of learning measures its commitment to civilization, to competitiveness, to the future itself. So schooling is a legitimate concern of every citizen, an issue as vital as national defense.

Preamble to *Labor Force 2000: Corporate America Responds*

The Triangle Coalition receives many inquiries from persons who have read or heard about problems in science, mathematics and technology education.

They may be practitioners in professions based on science, mathematics or technology who are concerned about the future of their disciplines; or they may be parents aspiring to good mathematics and science education for their children. Others are retired persons who want a constructive outlet for their energies and are looking for ways to use a lifetime of experience to help solve problems they have read and heard about.

Here are some of the reasons for their concerns:

- Since 1983 more than 400 separate reports have been issued on the status of precollege education in the United States. Each has painted a dreary picture of the state of affairs in our schools.

- In the area of mathematics, specifically, the federally-funded National Assessment of Educational Progress, which regularly administers nationwide tests in a variety of curriculum areas to carefully structured samples of fourth, eighth and twelfth graders nationwide, reported in 1991 on mathematics tests administered in 1990.

  Overall, the Assessment concluded that fourth graders have a consistent grasp of decimals, percents and fractions, while none of the eighth graders tested showed the breadth of understanding necessary to begin study of relatively advanced mathematics. At the twelfth grade level the report was even more discouraging. While all the high school seniors demonstrated success with third-grade material, and 91 percent had mastered fifth-grade math,

fewer than half demonstrated a consistent grasp of percents, decimals, fractions and simple algebra; and only five percent showed an understanding of geometry and algebra that suggested preparedness for the study of relatively advanced mathematics.

- A number of reports on international comparisons of assessments have indicated that U.S. students perform poorly in mathematics and science, compared to students in other developed countries.

- Projections for the future workforce predict a shortfall of scientists and engineers by the end of the century. Many colleges report fewer students completing majors in science, mathematics and engineering.

It is also clear that a very large percentage of new entrants into the labor force in the next century will be women and members of minority populations. These are groups that historically have been underrepresented in science, mathematics and engineering professions. The problem seems to start early in the education process; for example, statistics show that women and minorities tend not to take science and mathematics courses in high school. Only three percent of girls who graduate from high school have taken physics.

This is part of a larger problem. Taken together, a full 50 percent of all American young people drop out of high school, leave college after a few weeks or months, or complete general-track programs in high school that prepare them for neither jobs nor college. The rate of attrition is particularly high for African-American males, 40 percent of whom leave school before completing the twelfth grade.

- In addition, much attention to education currently centers around a series of national goals for the year 2000 proposed by President Bush and the nation's governors. These include the goal that American students shall be first in the world in mathematics and science achievement by the year 2000. Other education goals proposed by the president and governors call for preparing all youngsters to be ready for schooling when they enter kindergarten or first grade; improving the dropout rate; and increasing

AMERICA'S EDUCATION GOALS

By the year 2000:

1. All children in America will start school ready to learn

2. The high school graduation rate will increase to at least 90 percent.

3. American students will leave grades four, eight and twelve having demonstrated competency in challenging subject matters including English, mathematics, science, history and geography; and every school in America will ensure that all students learn to use their minds well so they may be prepared for responsible citizenship, further learning and productive employment in our modern economy.

4. U.S. students will be first in the world in science and mathematics achievement.

5. Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

6. Every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning

In 1990 the president and the governors adopted six ambitious education goals. AMERICA 2000 is a strategy to achieve them

America 2000: An Education Strategy Sourcebook
U.S. Department of Education

student achievement in five core subjects including mathematics and science.

With these and other factors stimulating interest in what is going on in schools, many individuals and organizations have become interested in making a contribution to education.

In the areas of science and technology, it becomes apparent to anyone who looks closely that schools are resource-poor, compared to the world of business, museums and government. This leads to the obvious conclusion that the outside world can, and should, be a resource for education. And as people begin to think in these terms, it becomes equally clear that one of the best ways to marshal the science, mathematics and engineering resources available in a community is collaboration—or, to use our term, alliances.

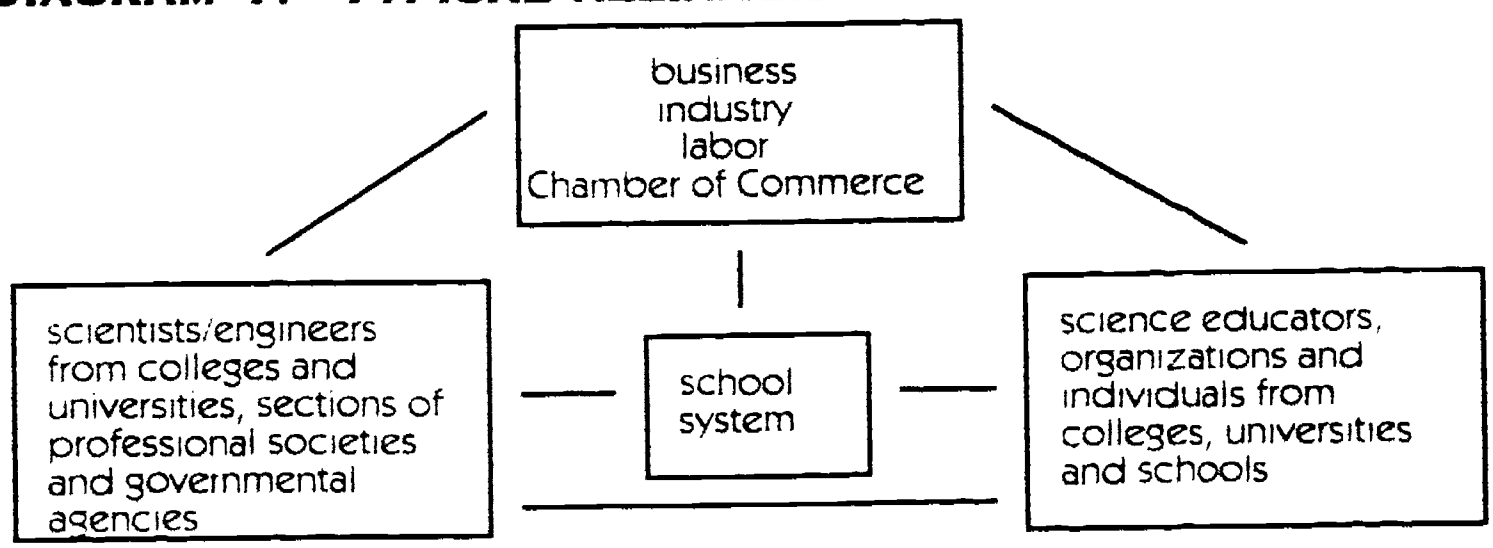
Here are some of the answers that successful alliance builders gave when asked their reasons for participating in alliances. An alliance:

- counters isolation by opening dialogue between teachers and other professionals;
- creates links between communities and schools;
- provides a forum for a systemic approach to solving education problems;
- identifies the elements needed to bring about educational change and develops projects that focus on these elements;
- connects school science with real-world experience;
- provides a broader information base from which teachers can help students make decisions about education goals and future employment opportunities;
- speaks in a collective voice about education needs, potentials and strategies;
- aspires to bring about consensus on education problems, needs and progress;
- informs the general public about educational problems, needs and progress;
- empowers all its partners and promotes collaboration;
- provides a mechanism for talented people from various sectors of society to volunteer their expertise for the welfare of America's youth;
- forges creative programs designed to improve precollege science, mathematics and technology education to help meet the special needs of disparate school districts;
- ties economic development to education by identifying the competencies that will be needed by future work forces, acknowledging that human resources are an important infrastructure for economic development.

There are examples of excellent work in education being done by single organizations acting alone—a corporation or government agency which involves itself with a single school, for instance.

But increasingly, experience shows the value of cross-cutting cooperative efforts by many groups acting together. For one thing, such efforts have better chances of survival. It does little good, and may do actual harm, for example, for a corporation to enter a school, become involved in the lives of teachers and students, and then depart abruptly as the result of a change in corporate ownership or philosophy. A collaborative community alliance can try to replace that corporate presence, helping the school to sustain its effort for improvement. And, in fact, an alliance can clearly present the need for continuity in community involvement, helping businesses and other agencies to see the long-term realities of becoming education partners. Diagram 1 illustrates this.

DIAGRAM 1. TYPICAL ALLIANCE INTERACTIONS



There are also synergistic effects of cooperation: in good alliances, the whole really is greater than the sum of its parts. Members of alliances often speak of the cross-fertilization of ideas that goes on, leading to new initiatives and better understanding of the issues that are involved in school/community collaboration.

There is also mutual support. Members of alliances may have had little experience in dealing with schools, which tend to be bureaucratic in structure and resistant to change. Burnout and loss of enthusiasm can easily happen if the community partner feels

alone with intractable problems such as complex lines of authority, teacher wariness or student apathy. In an alliance, these and other problems are up for discussion and resolution.

There is also much that can be learned from the experiences of other alliance members in terms of how best to reach students and teachers and what approaches and activities seem to have the greatest effect on student achievement and attitudes.

One important point: alliances can have a presence in the community that no one member alone may have, commanding respect and attention in business circles and in the press, as well as with school boards and school administrators. This can open doors, and it may be especially helpful if fund-raising is required.

2. ANATOMY OF AN ALLIANCE

This manual assumes that you, as an individual or part of an organization, have become interested in improving the performance of students in science and mathematics and that you are looking for a constructive way to put that interest into action.

The manual also premises that the best way for you to proceed is to make contact with other like-minded persons and organizations in your community or state. This is the process of alliance building.

As a guidepost and starting point, here are some basic principles that have emerged from the experiences of alliances for pre-college science, mathematics and technology education.

First, a definition: An alliance is a coalition of interested institutions and groups working together to promote the improvement and reform of science, mathematics and technology education.

Second, geographic scope: An alliance may be local, formed around a city or school system, or it may be regionally organized to include a number of schools, school districts, communities, colleges and universities. It may also be organized on a state or multi-state basis.

Third, membership: The members of an alliance are broadly representative of the community; the alliance aims to bring together all individuals and groups who have an interest or stake in improving science, mathematics, and technology education. The members or partners share equally in their commitment to the work of the alliance; there is no one dominant or controlling member or sector.

Fourth, structure: An alliance is organized in a flexible way to allow maximum communications between members and input to decision making. The organization structure serves the programs and activities of the alliance and links the partners together. It is flexible enough to change with emerging needs as they are encountered. Framing a constitution and bylaws can serve to achieve a flexible structure.

Fifth, responsibilities: Responsibilities are assigned within the structure to ensure policies are created and programs are established to meet goals and to track the progress of the coalition. Key decisions include all the members, and communications are open

CPEE MISSION STATEMENT

The mission statement of the Corridor Partnership for Excellence in Education (CPEE) is to translate the vision of "mustering the resources of Illinois in new ways to forge our own future by enhancing and promoting excellence in education at all levels and by acting as a catalyst to bring together business, research, education, government and labor leaders in Illinois; and supporting and enriching mathematics and science programs in the schools of Illinois by serving as a broker to exchange and share resources between business, research and education."

and honest. All partners assume responsibility for the alliance's agenda and become involved in its achievement.

With these definitions in mind, let's look at the steps in forming an alliance, beginning with identifying leaders and members and achieving consensus on philosophy and goals.

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ECIPEE'S THREE MAJOR GOALS

The three major goals of the East Central Illinois Partnership for Excellence in Education, Inc. are:

GOAL I To act as a catalyst in bringing together the leaders of business, industry, labor, education, government, civic and religious groups and individuals in order to promote excellence in education.

Three persons brought together the first group of people who considered the idea of a school-business partnership and discussed ways which it might promote excellence in education. An educational consultant served as the next catalyst and gathered a larger group of school and business people who met, brainstormed and decided to form a school-business partnership.

Each board meeting, committee meeting or quarterly meeting of ECIPEE served as a catalyst for ideas and concerns that were later translated into programs or activities sponsored by ECIPEE.

During the organization phase, it was agreed that much dialogue would be needed between and among the representative groups of the school-business partnership. It was further assumed that decisions about programs and activities would be made only after adequate exchanges of information and ideas had occurred.

Goal I implies that the partnership will seek out more and more members of the school, business and community groups in order to broaden the base of ideas, concerns and information that will result in the development of programs and activities that will have a long term, positive impact on educational achievement in east central Illinois.

LAEP SUGGESTS:

The Los Angeles Educational Partnership (LAEP) offers the following tips on successful alliance building:

1. The most effective alliances for instructional reform involve classroom teachers from the start and reflect a "grass-roots" approach rather than a "top-down" approach which would be the model if school administrators were the only educators involved.

2. Industry partners need to be made aware of the current situation in schools as well as the major reform movements in science and math education. One vehicle for this would be school and classroom visits to observe and assess the situation *State Frameworks; Project 2061;* and *Scope, Sequence and Coordination* are must readings as well as national reports (NAEP, etc.)

3 Alliances and partnerships should build on what is currently going on in local schools and combine the pedagogical knowledge of teachers with the content expertise from business/industry

4. There should be shared responsibility and problem solving between educators and business/industry rather than prescriptive reports or lists of recommendations from business/industry to educators

5 Solutions should include implementation of action plans rather than a list of recommendations.

Finally, Goal I includes the commitment to promote the development of school-business partnerships, beyond ECIPEE's immediate area. ECIPEE members can further this goal by speaking to other individuals and groups outside of our target area. Goal I activities also serve to promote school-business partnerships.

GOAL II To serve as a clearinghouse and broker for information and technical assistance regarding partnerships in education.

Subsequent to the formal organization, the ECIPEE coordinator began compiling a resource library of articles, pamphlets, newsletters, books, magazines, videotapes and other information relating to all aspects of school-business partnerships. These materials are catalogued and are available for loan to ECIPEE partners or others who are interested in developing school-business partnerships.

The resource library is maintained and future plans are to enter the information into a computer database. The ECIPEE newsletter, published four times a year, also serves as part of the information service.

Partnership leaders also present information to other groups about the organization, its development and activities.

GOAL III To provide a variety of direct experiences that will enrich, enhance and extend educational opportunities and help students to succeed in the work world.

The first program sponsored by ECIPEE was the Saturday Challenge series, cosponsored with the Corridor Partnership for Excellence in Education of Aurora, Illinois and the Illinois Mathematics and Science Academy.

High school students were invited to attend six Saturday sessions at which they heard outstanding professionals describe their work in the fields of math, science and technology. The evaluation was positive and the program committee recommended that Saturday Challenge be continued.

To maintain the initial momentum of the partnership, two other programs were undertaken: the development of a hands-on

NJ BISEC'S GOALS

The New Jersey Business/Industry/Science Education Consortium (NJ BISEC) was organized during the summer of 1981 to bring together representatives of these three sectors on a continuing basis to interact on pre-college science and mathematics education issues of mutual concern. The consortium is dedicated to improving the competencies in science and mathematics among New Jersey teachers and concomitantly their students. It also seeks to advance scientific and technological literacy among those within the education systems of the state.

The goals are as follows:

- help upgrade the quality of the teaching and learning of science, mathematics, computer science and technology in the elementary, junior and senior high schools in New Jersey;
- provide diverse career information in the fields of science, mathematics, and technology so that teachers may more reliably and enthusiastically communicate career information to their students,
- provide issue-oriented activities that elucidate the relationships among science, technology and society as well as programs to improve scientific and technological literacy,
- strengthen the ties between the education, business and industrial segments of our society

science and mathematics museum and compilation of a list of tutoring programs currently available to at-risk students in grades K-12.

The program committee meets several times during the year to discuss possible approaches to reaching noncollege-bound high school students with programs and activities to encourage academic achievement and acquisition of good work skills. Several examples of model programs that have been developed around the country have been studied. Program committee members concluded that strong incentives are needed to reach the student, and that business and industry partners will need to make strong commitments to provide jobs for students who participate in any long-term program ECIPEE proposes.

3. IDENTIFYING LEADERSHIP AND RECRUITING PARTNERS

Generally, an alliance is composed of a number of people who have a stake in the quality of science, mathematics, and technology education. This can include a very broad range of organizations and individuals.

To identify potential alliance members in a community is the first task of alliance building. But even at this first step, leadership is required; coalitions do not come about spontaneously, no matter how strong the interest or how good the intentions of the prospective participants.

From the experiences of a decade of alliance building in education, it's possible to identify some characteristics of successful organizers, though it must be cautioned that only rarely, if ever, are all of these found in the same individual. There is need, in other words, for a team of people who will take on various responsibilities. Sometimes, this can mean a division of labor between those who have the vision and those who follow through on details—both are equally needed.

Overall, leadership in creating an alliance requires some or all of the following qualities:

- willingness to commit a substantial amount of time to selling the idea
- ability to take a stand without fear of negative career consequences (such persons can be particularly valuable in the initial stages of organization since they have often attained personal and professional security)
- connections with networks of other people
- proficiency in marketing and communication—for example, the ability to articulate to prospective partners the vision of collaboration and education reform
- flexibility—organizers should not be committed to quick closure on decisions
- ability to take criticism without undue sensitivity
- ability to delegate duties
- ability to share recognition, power, ideas and credit; in other words, organizers should not be given to defending any particular turf
- an ability to get people working together
- willingness to broker and catalyze developments rather than directing them from any position of central authority

THE ATLANTA SECME ALLIANCE

Here is an example of how one alliance got started:

In organizing a local alliance, the regional Southeastern Consortium for Minorities in Engineering (SECME) organization asked Dick Snelling, executive vice president of networks for Southern Bell, to provide the leadership. Mr. Snelling made personal contact with upper level managers in some thirty-five corporations and businesses. He then hosted a series of breakfasts which were attended by the managers he had identified, most of whom were company vice presidents. After giving an overview of SECME, the purpose of the alliance was discussed. Each attendee was asked to name an official representative from his company within two weeks. This was a person who could contribute at least four hours per month to the alliance. SECME asked the superintendents of the Fulton County and Atlanta public school systems to identify personnel to participate. The same request was made of the president and dean of engineering of Georgia Tech. An organizational meeting was held during the next month and attended by twenty-six company representatives, school system and university personnel.

Remember in searching for partners for a local or statewide alliance to utilize the resources of the Triangle Coalition and other national organizations which maintain lists of members and related organizations. For example, you can use the *Triangle Coalition Member and Affiliate Contact Directory,* which lists local operating plants and association chapters for national corporations, scientific and engineering societies and education associations. Each entry includes a brief introduction, areas of interest and resources available for education and a protocol for contacting the organization.

In addition, the Triangle Coalition, and other national groups that support the formation of partnerships and alliances, provide services including consultation and clearinghouses. They may also be able to assist local alliance organizers with letters of introduction.

For a list of national organizations see Appendix 2.

- ability to generate financial support
- negotiating skills
- ability to stimulate a feeling of ownership in the alliance
- commitment to improving science, mathematics and technology education
- ability to articulate alliance objectives

Once leaders have been solicited or come forward, there are several ways to identify appropriate candidates for membership in the alliance. Initially a team of five or six enthusiastic individuals may hold a brainstorming session to come up with a list of all possible organizations and individuals who might have an interest. From this, draw up a "best prospects" list. This list should be short enough that personal contact can be made with someone in each organization. Recruitment letters seem to be less persuasive than telephone or face-to-face contacts. Your purposes are much too complex to be explained in a one-page letter which is the most people can be expected to read. Through discussion of the purpose of the alliance, and the potential benefits to individual members and community, the commitment of an individual and their organization can be secured.

Suggested groups and individuals for participation in an alliance include:

from the private sector:

- Chambers of Commerce
- trade associations
- local businesses and industries, including branches of national corporations
- local chapters of industrial unions

from government:

- research laboratories
- agencies (federal, state or local) that employ technical personnel in science, mathematics or technology
- state and local legislators (city council members, for example)
- representatives of the political power structure, from the mayor's office, city council, political parties, etc.

from education:

- state and local school boards
- state and local public and private school administrators including superintendents, principals of elementary and secondary schools, school system curriculum specialists, teachers and counselors
- representatives of local teachers and teacher unions
- representatives of professional discipline organizations such as the National Science Teachers

Technical expertise can be found in any community whether large or small. Most every community has one or more of the following: telephone repair person, electric utility service personnel, a medical clinic, a veterinarian, a pharmacist, an automobile repair shop, agri-business, etc. When you are looking for technical expertise, the yellow pages of your telephone book is an excellent place to begin. Thumb through the pages and pick out the businesses that hire technical personnel. The local pet shop has expertise on many animals. Don't forget to check with the hobby shops. Many people have hobbies that are totally unrelated to their careers. Hobbyists such as amateur radio operators have expertise that could spur a student into a whole new career path. Also call your local and state Chambers of Commerce for listings of businesses in your community.

Association, the National Council of Teachers of Mathematics and the International Technology Education Association
- representatives of science and technology museums
- science, mathematics, engineering and education faculty, researchers and administrators of colleges and universities
- parent organizations

<u>from the science and technology community:</u>
- chapters of national scientific and engineering societies such as the American Chemical Society, American Physical Society, American Medical Association, Sigma Xi, American Society of Mechanical Engineers, Institute of Electrical and Electronic Engineers, etc.

<u>others:</u>
- religious and social organizations
- local sections of organizations of retired persons such as the American Association of Retired Persons, the Retired Teachers Association and the National Executive Service Corps
- service organizations such as Kiwanis, Lions, etc.
- community groups such as 4-H, Scouts, environmental groups
- parents
- media (radio, TV, print), public relations companies or consultants, corporate public relations offices.

All communities are different: look at the human resources available in your particular situation. Remember, you want people to buy into this effort from the beginning—be as inclusive as possible and be sure to touch base with the movers and shakers in your community.

Support from top levels of authority in companies, the school system and universities is essential, but the people who will put your alliance into operation will come from all levels of practice and management and should be part of your planning from the beginning.

4. STEPS TO BUILDING CONSENSUS

At this point in the creation of your alliance, a group of leaders has come together and they have made contact with all the potential alliance partners they were able to identify. Some of those contacted have indicated interest.

It is now time to bring people together, to achieve consensus on what needs to be done in science, mathematics and technology education, and what your particular alliance will be able to do.

A good definition of consensus is "that point at which no one is completely satisfied but no one is in strong disagreement." Usually, consensus is achieved not by voting but by discussion, which can be lengthy and intense.

Why is consensus important? For one thing, this step in building an alliance is important because it attends to the needs of all the partners. Secondly, experience shows that alliances are more focused, more effective and operate more efficiently when the partners share a common view of what the alliance is about.

Some points to keep in mind at this stage: The group that meets may be small; this may be a nucleus of supporters who will later take the word out to larger groups. Also, the meeting is probably the first of many you will want to convene, so don't try to solve all the potential problems at this one session.

In assembling the group, keep in mind that a good mix of persons from elementary and secondary schools, business and industry, government agencies, universities and colleges, and interested community groups is needed if this activity is to be most effective.

The following is a suggested strategy for use with groups of from twenty to sixty people.

To open the meeting, the committee that has convened it should make some general explanation of what the meeting is all about, the rationale for the alliance, what kinds of decisions need to be made, and any other background information that will make people comfortable.

We recommend dividing the large group into small groups for discussion. The small groups should reflect the mix of the large group.

Attendees introduce themselves and explain briefly why they have come—what caused them to become interested in education and the possibility of an alliance, for example.

Then an assumption such as the following may be put before the group, possibly on an easel or overhead projector:

> *The use of community resources, both human and material, for science, mathematics and technology education has value and should be integral to the curriculum available to all children.*

The large group then divides into smaller groups for discussion—three to five people seated around a table or in a circle would be ideal. A leader should be named for each group.

The discussion groups are asked to prepare statements in support of or challenging the assumption; five to ten minutes should be sufficient for this activity. There will probably be few challenges, but those that emerge should be honored and discussed. A variety of comments in support of the assumption can be expected. A summary report is written on easel paper.

The large group then reconvenes and each discussion group is asked to present a brief oral report. The written reports of the small groups are taped to the walls for further discussion. The groups are also asked to provide concrete suggestions relative to the discussion topic, such as how to design an action plan to address the issue.

This cycle of large and small group discussions will be repeated with other issues that the committee may want to present, for example:

> *Is there a crisis in education?*
> *What is the nature of the crisis?*
> *What are some of the solutions?*
> *What are the potential benefits of a broad-based alliance or partnership for science, mathematics and technology education?*
> *What are the barriers to utilizing community resources and building broad-based alliances or partnerships for education?*

EIGHT QUESTIONS ASKED BY THE IOWA ALLIANCE FOR SCIENCE

1. Would an Iowa alliance for science be a good idea?
2. What organizations might be involved in an Iowa alliance?
3. What role(s) might be involved in an Iowa alliance?
4. How might an Iowa alliance be structured administratively?
5. How would an Iowa alliance affect (support, modify) existing public and private efforts to improve Iowa science, mathematics and technology education?
6. Where might an Iowa alliance for science be headquartered and staffed?
7. How might an Iowa alliance for science be funded?
8. Should our next step be a conference to assess the interest in and the nature of an Iowa alliance?

At the conclusion of the meeting, the session leaders will review briefly what has happened, including any agreement that seems to have been reached or issues that remain unresolved. Attendees are told that an overall report summarizing the reports of the discussion groups will be mailed promptly to each participant in the meeting.

To assure that you have correct mailing addresses circulate a sign-in sheet during the meeting.

The strategy described here acknowledges that alliance partners come from many and diverse backgrounds. It is intended to give them an opportunity to understand one another's viewpoints and to identify areas in which they can work together.

Remember—many alliance and partnerships have failed because the partners did not take the time to clarify their mission and goals. This step, which we call consensus building, is a necessary prelude to action. It is sometimes tempting to hurry through this process in order to get on to the program stage of the alliance, but spending a little extra time at this stage can prevent problems later in the life of the alliance.

More than one meeting may be needed to bring the alliance partners to consensus, about both the need for the alliance and what the alliance will actually do.

In addition, it is important to remember that as the alliance evolves, and as circumstances in the community or schools change, it will be necessary to revisit the consensus building process. In other words, building and maintaining consensus is a continual activity, even in established alliances.

The Dayton Area Technology Network's Questionnaire

The Dayton Area Technology Network sponsored a Regional Congress on Math and Science Education held in Dayton, Ohio in April 1990. The following are excerpts from pre-congress questionnaires sent by the Network to business and education leaders.

From the business leader questionnaire:

1. How would you rate the quality of math instruction in the public schools?
   a. very strong
   b. strong
   c. average
   d. weak
   e. very weak

2. Science instruction?
   a. very strong
   b. strong
   c. average
   d. weak
   e. very weak

3. What can your business offer public schools in an effort to improve the quality of math and science education?

4. Would your business be willing to participate in a regional effort with public schools to improve math and science education?
   ___ yes
   ___ no

5. Would your business be willing to encourage your employees to participate in their respective school districts?
   ___ yes
   ___ no

6. If yes to the two previous questions, in what capacity? If not, why not?

From the education leader questionnaire:

1. When comparing your program to other area schools, how would your rate the quality of your district's math instruction?
   a. very strong
   b. strong
   c. average
   d. weak
   e. very weak

2. What does your district need in order to make significant gains in math and science? Rank in importance with one (1) most important.
   ___ teacher mentorships in business.
   ___ increase resources.
   ___ more stringent requirements.
   ___ other

3. How can business best assist public education in improving math and science education?

Would your district be willing to participate in a regional effort with business and universities to improve math and science education?

___ yes
___ no

4. If yes, in what capacity? If not, why not?

Questions asked of both groups included:

What do you believe are the greatest challenges facing school districts in an effort to improve math and science education? Please indicate priority of concern with one (1) as greatest concern.

___ finding qualified teachers of math and science
___ lack of educational resources in the classroom
___ better understanding of the math and science needs of industry
___ parental encouragement and involvement with education
___ math and science curriculum
___ other

If you could wave a magic wand and remove one barrier to improving the math and science foundation of this region's youth, what barrier would you remove?

How effective do you believe regionalized business/education collaboration would be in helping to improve math and science education? Circle your response. Please comment on the way that regional collaboration would help.

a. very effective
b. effective
c. somewhat
d. a waste of time

5. KEY COMPONENTS OF SUCCESSFUL ALLIANCES

During the formation of a new alliance, the philosophy, mission, goals and objectives, action plans, communications, funding and evaluation will be constructed almost simultaneously as consensus building proceeds.

As the alliance matures, these areas will become more coherent, distinct and stable, but care must be taken to build mechanisms that allow for flexibility as the community and educational climate changes.

What follows is meant as a basis for discussion after overall group consensus and commitment has been achieved.

Statement of philosophy

Though a statement of philosophy seems at first glance to be a somewhat peripheral notion, it has been found to be very important. A statement of philosophy can be described as the rationales that form the foundation of the alliance, expressing how the alliance views education issues both locally and nationally and why it proposes a broad-based response. The philosophy is a guide as to how the alliance will proceed in the future in many areas.

Example: The community at large should be involved in decisions to improve and reform precollege education.

Mission statement

A mission statement is a short and concise explanation of what the alliance will do. It targets a population and serves as a litmus test for determining if the goals and objectives that are developed are within the purview of the alliance.

Example: The purpose of the alliance is to assist in bringing about the reform of precollege science, mathematics and technology education for all students.

Goals and objectives

The mission statement is the broad statement of purpose that reflect the ideas and specific needs of an alliance. They are general and usually not measurable. Goals and objectives are statements of specific intent that tell what will be accomplished, when and by whom as the alliance moves toward its mission. They are intended to be measured by some form of evaluation. It is impor-

tant that the concepts of measurement and evaluation be discussed at the time objectives are being set.

Example: The alliance has the primary goal of aiding and assisting teachers to provide up-to-date science and technology instruction. To achieve this goal the alliance has set a secondary goal of making paid summer industrial internships available over a five-year period for ten percent of the science and mathematics teachers in the service area.

Action plans

With a well thought-out set of goals and objectives, the alliance can now develop action plans for implementing its objectives. Action plans say what people will do, have deadlines and commit specific resources and people. Action plans may be divided among several partners, but it is important to have commitment from each member of the team. Results of the action plan must be monitored at each step along the way; this assessment of how well things are going is intended to assure success and should not be used as criticism.

Example: Ten local corporations agree to put into place by the beginning of next year a summer industrial internship program for teachers; they begin with a planning meeting at which each partner describes specific arrangements for bringing teachers on board, how the teachers will be chosen, what they will do, who will supervise them, etc.

Communication

Communication is at the very heart of every successful alliance. It is essential that partners be in regular communication. The communication must be open in order to build trust and confidence between partners who are coming from many different backgrounds.

Example: A newsletter, regularly produced and distributed, is usually a must. Media or public relations partners may take on this chore. Also, there should be timely reports to all the partners of actions taken by staff, boards or task forces.

Monitoring, assessing and evaluating

This is important to the continued existence of an alliance. If the alliance cannot show evidence of its effectiveness, prospective

RULES OF THUMB

Strive for open communication among all partners by respecting the positions and ideas of each partner. Encourage frank and honest discussion to prevent domination by narrow interests. Tolerate divergent viewpoints and maximize the benefits of healthy conflict.

Encourage all partners to assume responsibility for changing the current status of education by the skillful assignment of individuals on task forces, councils and executive committees.

Select staff that is representative of the various sectors that compose the alliance. Avoid allowing any one partner to dominate policy or operational decisions.

Develop a mission statement and goals that reflect the consensus of all partners. Write a mission statement and objectives in positive terms. Develop clearly stated and achievable goals.

Communicate to partners that their personal participation is primary in the objectives of an alliance and that this participation is a precursor to gaining the needed financial support.

Seek funding from multiple sources rather than settling on a single source of funding that may allow a single partner to be recognized or dominate the work of many.

Recognize that in-kind contributions are just as valuable as cash.

Encourage every partner to assume responsibility for the health of the alliance.

Give every partner credit for the success of the alliance.

continued on next page

new partners will be reluctant to join and funders may choose not to support. In addition, by its very nature, alliance building calls for regular feedback, to assure that desired results are being achieved.

Example of evaluation: During the past year the alliance brokered summer internships for teachers in a number of corporations. The university worked with this team of teachers to produce a package of curriculum modules. Students who were exposed to these teachers and lessons were surveyed; the survey showed that these students were more likely than a control group to elect a second semester of science, consider a technical position after high school, or choose science as a college major.

Alliance building is a process that needs to be monitored continuously. As information is obtained, it needs to be fed back into the system to ensure that the desired results are being obtained. This requires honest communications among all the partners. Alliance building is the process of building relationships that bring all the stakeholders together to address problems that none of the partners could handle by themselves. In building an alliance the process itself is a product.

RULES OF THUMB, CONT.

Avoid assuming a paternalistic attitude toward schools and educators, or blaming educators or any one sector for the current ills of America's educational situation.

Encourage team problem solving and decision making that includes interaction between policymakers, managers and practitioners from each of the partner organizations. Avoid authoritarian, top-down leadership.

Choose a host organization as a home for the alliance which will be perceived as politically neutral and geographically accessible by all partners.

Avoid competition with the goals and activities of any single partner by not sponsoring projects that a single partner is in a better position to implement.

6. ACTION AND IMPLEMENTATION

After an alliance is formed and has worked to build consensus among its members, it is important that the alliance demonstrate immediately that it has credibility and will be useful to its partners.

When an alliance implements programs shortly after formation, partners see immediate benefits and results from their collaboration. This fosters increased understanding between the participating groups and enables them to target needs, problems and potential resources.

This is a large order, since in the beginning the partners in an alliance may feel their time is fully taken up with simply learning to work together. In addition, projects that involve direct education activities require research, consultation with the schools, allocation of resources and a lot of one-on-one contacts. But the alliance's early projects set the tone for potential long-term programs, and if nothing seems to be happening for a long while after initial organization, partners will fall off and take their energies elsewhere.

It is important to note here that alliances are often made up of people who have not been inside an elementary or secondary school for many years. They may not understand very well the subtleties and complexities of today's schools. It should be made clear to all alliance members that educators are a vital part of the partnership, without whom not much can be done.

It should also be emphasized that schools follow a curriculum in science, mathematics and technology, and any initiatives by an alliance should—in fact, must—take the curriculum into account. This means learning about the textbooks that are being used, the level of mastery that is expected of students, and teachers' preparation for teaching the curriculum. In all of those areas, the alliance may be able to make significant contributions, but it needs to do its homework first. It is important to recognize that changes in the curriculum are legally within the province of the boards of education. This punctuates the wisdom of including school administrators and other representatives in the alliance.

Alliance partners also need to take note of the many issues, both in education and in society, that impact the teaching of science, mathematics and technology in schools. That, in turn, will influence the kinds of programs an alliance adopts. The following paragraphs examine some of these issues.

Teacher isolation is a major problem in most school systems. Teachers do not usually have regular opportunities to discuss their difficulties or their successes in teaching science and technology. This is particularly true for teachers in the elementary grades, though secondary school science, mathematics and technology teachers also say they would benefit from regular meetings within and across academic disciplines.

Teachers in elementary schools (grades kindergarten through six) often feel anxious and inadequate about teaching science,

PRISM

The Philadelphia Partnership for Education (PATHS/PRISM) is a private non-profit 501(c)3 partnership to improve instruction and curriculum in science, mathematics, humanities and the arts. Its board of directors represent industry, colleges and universities, the School District of Philadelphia, unions, museums and cultural institutions, governmental agencies and community organizations. Although mostly teacher-centered, its programs include direct intervention with minority students in the schools. In a district with 14,000 teachers in 256 schools with 200,000 students, PRISM (the Philadelphia Renaissance in Science and Mathematics) offers teachers summer institutes with academic-year follow-up, industry fellowships, mini- and collaborative grants, teacher-to-teacher workshops and colloquia, elementary science kits and whole school restructuring programs. In addition, PATHS/PRISM serves as a center for national and regional programs for school reform such as Project 2061, Project QUASAR, the Urban Math/Science Collaborative, the Comprehensive Regional Center for Minority Access and PRIME (Philadelphia Regional Introduction for Minorities in Engineering). Primary funding comes from the National Science Foundation, the Pew Charitable Trusts, AAAS, Ford Foundation, Merck Sharp & Dohme, ARCO and the School District of Philadelphia.

mathematics and technology. Many teachers studied no science or mathematics in college and had only minimal training in high school, often because they feared or disliked the subjects. In addition, their preservice professional preparation for teaching math and science was often limited. Given these facts, and the pressures now being placed on teachers to excel in these areas, it seems clear that any program to increase teachers' knowledge and comfort level in mathematics and science would be very useful.

In addition, both elementary and secondary teachers say they would benefit from opportunities to meet other professionals in science, mathematics and technology, and to see actual work place applications of their subjects.

Turned-off, apathetic or resistant students are a real and difficult issue in contemporary education and particularly in science and mathematics. These are considered hard subjects and many students prefer to avoid them. It also seems that by the time they reach elective courses in high school, many students are so turned off by their earlier science and mathematics experiences that they have lost interest. This can be true of very capable female students, for example, who often receive indirect messages that boys are better at science and mathematics. Many alliances, recognizing these problems, have made it an objective to stimulate student curiosity and confidence about science, mathematics and technology.

One of the largest challenges in education is the lack of participation by females and persons from minority groups in science, mathematics and technology. Women and minorities will make up over 60 percent of new entrants to the work force by the year 2000. Young female and minority students now in school constitute the largest single untapped source of future teachers and workers, but they are currently seriously underrepresented in classes and courses in science, mathematics and technology. This is sometimes the result of social and education practices that "filter" girls and minority students out of what are seen as traditionally masculine fields. Whatever the reason, it is imperative that alliances give special attention to involving underrepresented groups in their programs.

Many problems in the larger society impact students and schools. Drugs, poverty, violence, television, stress in the family, peer pressure and even video games compete with the classroom for the attention of young people. It should not be surprising that these influences often outweigh whatever incentives there are to study hard in school. It can be a major contribution of alliances to provide experiences that broaden students' horizons, reduce isolation and stimulate interest. Alliances can support achievement through services such as tutoring. Attracting and keeping students in science, mathematics and technology is critical to the nation's future and requires attention and cooperation from all the partners in an alliance.

Most alliance partners already know of and understand many of these issues. In your consensus building stage, you probably discussed them, and others unique to your community. By now it

Systemic Change

Educational systems are complex organizations. Many individuals and groups have significant influence over them and hold stakes in their operation, structure, performance and outcomes. To bring about educational improvements through integrated systemic change demands concerted action at many levels and by many persons.

The anticipated effects of these changes will be to increase the knowledge of science and mathematics acquired by all students at all levels and to afford every student the maximum opportunity to acquire the habits of mind and critical thinking skills that characterize effective use of mathematics and science.

A further effect of such changes would be to enable students to understand the role and influence of technology as one of a number of ways by which science and mathematics are related to the physical world and the human condition. Such changes should benefit education in all subject matter areas, but when implemented will move the United States toward the goal enunciated by the president and the nation's governors, of making American students the first in the world in mathematics and science achievement by the year 2000.

"Statewide Systemic Initiative in Science, Mathematics, and Engineering Education," Program Solicitation, National Science Foundation, 1990

can be assumed that the partners in your alliance are eager to do something specific and concrete to help—which, after all, is why they became part of the alliance in the first place.

Taking Action

As a first principle when developing alliance projects to support science, mathematics and technology education remember this: An alliance should not sponsor a project that can better be undertaken by one partner alone.

The purpose of an alliance is to bring together a wide range of services and options and focus them for maximum effect on an identified issue. This is the special strength of alliances.

There are many examples, some excellent, some less good, of one-to-one cooperation between a corporation or agency and a school. These can and will continue, but they are not what alliances are about. By their community-wide presence, alliances are able to go beyond short-term activities which often lack staying power to effect change or improvement that will outlast the individual alliance members.

Once the alliance has identified the issues it wants to address, how does it initiate activities? As a first step, this certainly is the time to look at case studies of projects that have been in operation around the country for some years. Organizations such as the Triangle Coalition and others that are listed in the appendices to this publication have made a point of collecting information about local projects and programs, arranged for easy retrieval by the nature and focus of the activity. These models aren't intended to be followed slavishly by your alliance; rather they will stimulate your members' imaginations and perhaps help you to avoid some missteps and mistakes.

The following are some of the activities alliances currently sponsor:

- summer internships in business or industry for teachers and students
- minigrants to teachers for curriculum innovation and student projects
- volunteers for tutoring, mentoring, guest lecturing, sponsoring clubs, judging contests, etc.

WHAT DOES SYSTEMIC REFORM MEAN?

Systemic reform entails permanence and a comprehensive approach to programs which will change existing structures to increase the knowledge of science and mathematics acquired by all students at all educational levels. The results will afford every student the maximum opportunity to acquire the habits of mind and critical thinking skills that characterize effective use of science and mathematics.

Summer courses for teachers are enrichment that may be a necessary condition for change, but may not sufficient for solving our educational problems. The reform of science, mathematics and technology education cannot proceed in a vacuum and ignore other school restructuring and subject matter efforts.

The student learning environment will be formed by the instruction and curriculum that are managed by teachers and administrators, the policies adopted by school boards, the pedagogy and content of the curriculum and a host of other factors. Because of the relationships among all parts of this complex system, a systems approach to reforming the quality of education is needed.

Systemic reform may begin with a studied determination of what minimal skills and knowledge a student should possess upon exiting the school program. Determining the student outcomes is the business of every partner including higher education, industry, government agencies, community groups, parents and school personnel. A consensus on the student outcomes forms the foundation for creating a more effective curriculum, which informs the other components of teacher training, management and policy making.

- institutes for professional development of teachers
- speakers bureaus
- loans and donations of equipment, financial support
- scholarships and fellowships
- technical assistance—proposal writing, consulting, etc.
- curriculum assistance
- program development
- public awareness campaigns
- legislative/policy advocacy
- job placement
- career guidance
- clearinghouses, databases and hotlines
- projects for women and minorities
- computer-based telecommunications networks
- administrator training
- development of elementary and secondary school science programs
- school restructuring

This list is far from inclusive; the special circumstances of your community will suggest other options as well. Other examples are given in Appendix 6. Bear in mind that to make any of these happen, the alliance must include the school system and its teachers as active partners in decision making and project implementation. Otherwise, quite simply, nothing is going to work!

The capacity to implement programs with the schools takes time to develop. Each alliance needs to build trust and credibility with school districts and the community before programs are implemented. Early involvement of the school district is essential to the success of the alliance. A study of local school needs must be done before programs are implemented. The special needs of minority populations should be an important part of the needs analysis.

The old adage "success breeds success," should prompt the alliance to publicize the programs it generates and helps to sponsor. Press releases which have photographs of students and teachers participating in an alliance-initiated program and which mention alliance member organizations help gain visibility.

This raises another issue: At some point in the development of an alliance for science, mathematics and technology education, the

SOME ALLIANCE MANAGEMENT ISSUES

1. How will the mission statement and philosophical position be developed?
2. How will all the partners' needs be assessed, goals developed and priorities set?
3. What is the best organizational structure to serve the mission and goals?
4. How and on what conditions will partners be recruited?
5. How will programs and projects be integrated in a manner consistent with the mission and goals of the alliance?
6. How will programs and projects be monitored, assessed and evaluated, as well as the broader alliance structure?
7. What kind of fiscal plan will support and fund the alliance activities?
8. How will the partners communicate with each other and the alliance office?
9. How will public relations with the community at large, national groups and liaison activities with state policy-makers be conducted?
10. How will the alliance liaise with other kinds of local, national and state partnerships and organizations with similar goals?

partners will have to decide to what degree they want to be involved in school reform, as opposed to enriching or enhancing what is already being done. There is no doubt that enrichment in the form of coordinating and mobilizing community resources in support of teachers and schools is needed. However, that is a low-risk philosophy and should be recognized as such. School reform activities, on the other hand, are high-risk, and can become uncomfortable for many partners. If the partners decide that systemic reform is what is needed, then the alliance can become a vehicle for planning and moving such an agenda forward.

Examples of systemic school reform activities related to science, mathematics and technology education are:

- curriculum review and revision, such as that proposed by the American Association for the Advancement of Science in its Project 2061; the National Science Teachers Association's Scope, Sequence and Coordination project; and the mathematics standards set by the National Council of Teachers of Mathematics;
- cooperative program development and decision making with schools;
- integrated preservice and inservice training of school teachers and administrators, such as courses in how to implement organizational restructuring;
- management training;
- school policy development.

But whatever route your alliance chooses to go, remember that alliances are the glue that holds the effort to improve, reform or enhance education together and gives it strength.

The alliance can bring to the school reform table the informed perspective of national organizations and other successful approaches in the areas of school management and curriculum reform. The notion "think globally and act locally" applies here. There are 16,000 different school districts in the United States, but the problems we face as a people are national in nature and will affect us in the global marketplace. The alliance can help strike the balance to meeting our needs nationally as well as locally.

7. A WORD ABOUT ORGANIZATION

We have spoken of "your alliance" as a functioning entity.

But any effort to bring many individuals and groups together in an undertaking needs, after the initial stages of inspiration and voluntary leadership, an organized, central and accountable management structure.

Alliances for science, mathematics, and technology education now in place around the country have a variety of administrative styles. But some general guidelines can be drawn from their experience, and from management theory, for new alliances to consider.

- Design the structure of your organization to meet the expressed and common needs of your partners. Don't force the mission, programs and projects of your alliance to fit a preconceived "model" organizational structure.

- Beware of expending the bulk of initial meeting time on structure, before consensus on the mission of the alliance and some agreed-upon goals are in place. On the other hand, some structure is necessary if a sense of cohesion is to develop among members. Elaborate structure is not desirable, particularly in the early stage of the alliance.

- Be sure the organizational structure allows for changes as the alliance grows. Be prepared to alter it to fit the needs and personalities of the members. Allow for continued consensus building as new members join the alliance.

- There are some formalities. You should have a constitution and a set of bylaws, simply because this is good business practice. Also, if in the future you want to apply for a tax-exempt 501(c)3 status, a constitution and bylaws are required by the Internal Revenue Service. Designate in the bylaws a clear chain of command: who will set policy, who will determine staff salary and tenure and who will be responsible for making decisions and implementing actions.

- If you will be raising funds or seeking donations, you will want either to file for 501(c)3 nonprofit status or to become imbedded in an organization that has such status.

NJ BISEC

The New Jersey Business/Industry/Science Education Consortium (NJ BISEC) has an executive board constitutionally empowered to make decisions, both programmatic and financial. It meets for several hours eleven months a year. In addition to the NJ BISEC officers, the executive board is comprised of the chairmen of all the committees (elementary school programs, middle school programs, secondary school programs, career programs, conventions, evaluation, publicity, public relations, teacher improvement project (summer interns), minigrants and awards/banquets), representatives from the New Jersey State Department of Education and the executive director. The executive director and the administrative assistant are both independent contractors hired on a part-time basis by the executive board. Their contracts are reviewed annually. The NJ BISEC is headquartered at the Stevens Institute of Technology.

There are pros and cons each way. If you become an independent organization, along with independence come responsibilities, including paperwork. On the other hand, a completely independent alliance may be seen as an honest broker, with no turf to protect. If you go the other route and become part of another nonprofit organization, such as a university or foundation, keep in mind that decisions made by the alliance could come into conflict with the parent organization's policies. As an independent organization you will have to manage your own fiscal affairs; universities and other sponsors will usually take care of that for you.

- Finally, remember that an effective organizational structure places the responsibility for success and failure equally with all partners.

- Implicit in all of this is that you either will or will not have paid staff. Here, we suggest you look at the experiences of existing coalitions, which have solved that question in various ways. The weight of their opinion, however, seems to be that you can't do without some paid employees, full- or part-time.

FUNDING AND OTHER SUPPORT

Financial support of an alliance should be of two types: core support for day-to-day operations and support for programs and projects. Both are important and they may have different sources of funds. The core support, which should come from the member organizations, provides the basic support of the office. This support group includes all alliance members—business, industry and labor; science and engineering individuals and organizations; and education, including boards of education, colleges and universities.

Program support will be tied closely to the goals and priorities of the group.

If the activities include programs like teacher workshops, curriculum development and summer work programs, you may need other sources of financial assistance. Foundations, both national

COLORADO ALLIANCE FOR SCIENCE

The Colorado Alliance for Science, in order to service the needs in all areas of the state, has twelve regions with an institution of higher education serving as the focal point in each region. At the regional level, all members of the Alliance meet together to identify needs and address issues of concern. Each of these regions identifies a representative to serve on the state council. There are currently seven statewide councils: business and industry, higher education, school policymakers and administrators, governmental agencies, mathematics educators, science educators and technology educators. These statewide councils meet at least twice yearly to share information and address issues that are best handled within their areas of expertise. Five members of each of these councils are elected by their members to serve a steering committee. The responsibility of this steering committee is to set policy and direction for the Alliance. The chairs of each of these councils serve on the Alliance executive board which carries out the policies set by the steering committee. The Alliance staff report to the executive board. Salaries and tenure of the staff are determined by the executive board. This executive board meets as required, at least twice yearly, to review the programs with the staff and to give the staff guidance and direction

and local, of which there are many, are one possible source of funds. Local and state governments are another.

Sources of funds

Support for the basic operation of an alliance should, in most cases, be obtained locally. Ask businesses and industries for contributions, perhaps in the form of annual dues, for day-to-day operations. School districts may have funds to contribute and state departments of education, colleges and universities are also likely sources of financial support. Many universities have science, mathematics and technology education centers. Funds supporting these centers can help to support an alliance.

Special projects may be supported by contributions, but also consider other funding agencies such as local and national foundations. Federal funds from agencies such as the Department of Education and the National Science Foundation may be available on a competitive basis to support certain kinds of projects. State departments of education have access to federal funds for some educational programs. Approach them to determine what sorts of projects they are willing to consider for financial support.

Non-Financial Support

Many local organizations and individuals may assist in the programs and projects of the alliance without compensation. For example, many retired scientists and engineers are willing and eager to volunteer as tutors for students and as mentors for teachers. Industrial and government laboratories are sometimes willing to donate science and engineering equipment that is no longer useful for teaching and research, but is perfectly adequate for educational purposes.

Industries, colleges and universities, and government laboratories may be willing to organize visits and field trips for student groups. Some retired scientists and engineers might organize field trips to enable students to observe and study phenomena in the local environment—geology, botany, zoology, industrial chemistry, engineering and similar topics.

APPENDIX 1
TRIANGLE COALITION DESCRIPTION

The Triangle Coalition for Science and Technology Education was established in April of 1985. The Triangle Coalition is directed by Dr. John M. Fowler and operates through a small staff located in College Park, Maryland. In September, 1990 the Triangle Coalition became a non-profit organization with an independent 501(c)3 status.

The Triangle Coalition is an organization comprised of more than 100 national members with representation from business, industry and labor; scientific and engineering societies; education associations; and governmental agencies. Over sixty alliances have also joined as affiliate members.

The Triangle Coalition has three unique features that distinguish it from all the other national organizations working for science education reform.

- ▲ It involves organizations from business, industry and labor as equal partners with those from science, engineering and education in efforts to reform science and technology education in kindergarten through twelfth grade.

- ▲ It provides direct linkages with a large number of broad-based local alliances which are working at the state and local level to improve science and technology education.

- ▲ It has no vested interest in any one mechanism of reform.

The Triangle Coalition concentrates its efforts in three areas of action: communication, resource mobilization and advocacy. In each area it works to link and capitalize on the unique resources of its national network of alliances and member organizations.

The core operation of the Triangle Coalition—staff and office, task force and steering committee meetings—is supported by scaled assessments on member organizations. Specific projects are supported by external grants and contributions.

Publications

Triangle Coalition Member and Affiliate Contact Directory; Triangle Coalition Network News; reprints of *Triangle Coalition Network News* articles on alliance programs; and the Triangle Coalition career materials bibliography.

Address and Phone

Triangle Coalition for Science and Technology Education
5112 Berwyn Road, 3rd Floor
College Park, Maryland 20740
(301) 220-0885

APPENDIX 2

ALLIANCES FOR MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION

Among the major organizations that assist alliances are:

American Association for Higher Education
One Dupont Circle, Suite 600
Washington, DC 20036
(202) 293-6440

American Association for the Advancement of Science
1333 H Street, NW
Washington, DC 20005
(202) 326-6670

American Chemical Society
1155 Sixteenth Street, NW
Washington, DC 20036
(202) 872-4388

American Physical Society
335 East 45th Street
New York, NY 10017
(212) 682-7341

Association of Science-Technology Centers
1413 K Street, NW, Tenth Floor
Washington, DC 2005-3405
(202) 371-1171

Association for Supervision and Curriculum Development
1250 North Pitt Street
Alexandria, VA 22314
(703) 549-9110

Biological Sciences Curriculum Study
830 North Tejon Street, Suite 405
Colorado Springs, CO 80903
(719) 473-2233

Education Development Center, Inc.
55 Chapel Street
Newton, MA 02160
(617) 969-7100

International Technology Education Association
1914 Association Drive
Reston, VA 22091
(703) 860-2100

Lawrence Hall of Science
University of California-Berkeley
Berkeley, CA 94720
(510) 642-4193

Mathematical Sciences Education Board
818 Connecticut Avenue, NW, #500
Washington, DC 20006
(202) 334-3294

National Association of Biology Teachers
11250 Roger Bacon Drive, #19
Reston, VA 22090
(703) 471-1134

National Association of Partners in Education, Inc.
209 Madison Street, Suite 401
Alexandria, VA 22314
(703) 836-4880

National Association of Precollege Directors
51 Astor Place
New York, NY 10003
(212) 288-0950

National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091
(703) 620-9840

National Science Foundation
1800 G Street, NW
Washington, DC 20550
(202) 357-7000

National Science Resources Center
900 Jefferson Drive, SW, Room 1201
Washington, DC 20560
(202) 357-2555

National Science Teachers Association
1742 Connecticut Avenue, NW
Washington, DC 20009
(202) 328-5800

Public Education Fund
601 Thirteenth Street, NW, Suite 307 South
Washington, DC 20005
(202) 785-9292

United States Department of Education
330 C Street, SW
Washington, DC 20202
(202) 708-5366

APPENDIX 3
ACADEMIC ALLIANCES

Academic alliances provide a forum for university professors and precollege teachers to meet on a regular basis to share teaching strategies, subject matter information and a host of other resources. The Triangle Coalition supports the academic science alliance movement because of the benefits to science teaching, teachers and students. Academic alliances will assist in removing the isolation between precollege and higher education teaching.

The Triangle Coalition encourages academic alliances also to include members of the broader community from business and industry, government agencies and other community groups who have a stake in science education. With broader community representation, academic alliances may evolve to provide a range of teacher programs and grow strong enough to effect local and state science education policy.

Please contact the individuals at the organizations listed below for more specific information on building academic alliances:

Phil Daro, Executive Director
The American Mathematics Project
University of California-Berkeley
300 Lakeside Drive, 18th Floor
Oakland, CA 94612
(510) 987-9508

Amie Knox, Consultant
Academic Alliance in Chemistry
Camille and Henry Dreyfus Foundation
10 Winding Lane
Greenwich, CT 06830
(203) 869-0884

Charlene Reich, Project Manager
Local Physics Alliances
American Physical Society
335 East 45th Street
New York, NY 10017
(212) 682-7341

Karen Goldberg, Project Associate
Academic Alliances
American Association for Higher Education
One Dupont Circle, Suite 600
Washington, DC 20036
(202) 293-6440

APPENDIX 4

CHECKLIST OF WHO TO INVOLVE IN ALLIANCES FOR SCIENCE, MATHEMATICS, AND TECHNOLOGY EDUCATION

SCIENCE AND ENGINEERING

local sections of professional societies

- American Chemical Society—chemists
- American Geological Institute—geologists
- American Institute of Biological Sciences—biologists
- American Physical Society—physicists
- American Institute of Physics—physicists
- American Society of Mechanical Engineers—mechanical engineers
- Institute of Electrical and Electronics Engineers—electrical and electronics engineers
- National Association of Academies of Science—academies of science
- American Astronomical Society—astronomers
- Acoustical Society of America—acoustical scientists
- American Nuclear Society—nuclear scientists
- Federation of American Societies for Experimental Biology—experimental biologists
- health professionals

BUSINESS, INDUSTRY AND LABOR

- state chambers of commerce
- local chambers of commerce
- local trade associations
- state, regional and local industries and businesses
- state, regional and local labor unions
- textbook publishing companies
- science supply houses

EDUCATION

local school districts

- superintendents
- subject area supervisors
- principals
- guidance counselors
- science teachers
- mathematics teachers
- technology teachers
- agriculture teachers
- elementary teachers
- teacher unions

universities and colleges

- presidents
- provosts
- vice presidents
- deans
- professors—research scientists
- professors—science and math education

local sections of professional associations

- American Association of Physics Teachers—physics teachers
- American Federation of Teachers—teachers union
- Association for Supervision and Curriculum Development—curriculum developers
- Association for the Education of Teachers in Science—university science teacher educators
- Association of Science-Technology Centers—science and technology centers
- Council for Elementary Science International—elementary science teachers
- Council of Chief State School Officers—state school officers
- Council of State Science Supervisors—state science supervisors
- International Technology Education Association—technology educators
- National Action Council for Minorities in Engineering, Inc.—precollege engineering programs
- National Association for Research in Science Teaching—science education researchers
- National Association of Biology Teachers—biology teachers
- National Association of Geology Teachers—geology teachers
- National Council of Teachers of Mathematics—mathematics teachers
- National Earth Science Teachers Association—earth science teachers
- National Education Association—teachers union
- National Energy Foundation—energy educators
- National Science Supervisors Association—district science supervisors
- National Science Teachers Association—science teachers
- Society for College Science Teachers—college science teachers
- National Association of Partners in Education, Inc.—school volunteers

- National Parent Teachers Association—parent teachers association
- state science, mathematics and technology teacher associations

GOVERNMENT

- state departments
- state directors of educators
- state science supervisors
- state mathematics supervisors
- governors science and technology committees
- governors economic development committees
- legislative representatives

local agencies
- county commissioners and executives
- county councilors
- mayors
- city councilors

federal agencies
- U.S. Department of Agriculture—soil conservation, 4-H
- National Aeronautics and Space Administration—research facilities
- government laboratories
- congressional representatives

OTHER GROUPS

- service clubs—rotary
- media—radio, tv, print
- American Association of Retired Persons—retired persons
- Future Farmers of America—farmers
- other alliances
- religious groups

APPENDIX 5

PRINCIPLES FOR BUILDING AND MAINTAINING ALLIANCES

1. *People* are the key to success. Interested individuals are necessary to internally muster an organization's support for an alliance.

2. *Structure* is a mark of a lasting alliance. Commitment, clarity of mission, goals, purpose and methods are all crucial components.

3. Before the alliance's role can be defined and common programmatic goals designed, partners must identify and understand mutual needs and benefits. Determine who does what best, but maintain partner equality to ensure stability. Two goals in alliance building are to increase the level of *shared ownership* and *create synergy*.

4. Successful alliances have very *flexible partners* who are able to listen and learn from each other before taking action.

5. Alliance organizers must become proficient in making a *five-minute pitch* to prospective partners. Succinctness indicates clarity of purpose.

6. An alliance needs an *evangelist* who is able to commit a substantial amount of time to selling the notion of collaboration and a *director* who will dedicate him/herself for a minimum of five years.

7. An alliance must have a *vision* to win individuals' time and organizations' commitment.

8. *Team building* is a major activity of any collaboration involving schools, businesses, industry, higher education, professional organizations, research laboratories, governmental agencies, community groups and individuals

9. Alliances seek a *systems approach* rather than a component "fix" to solving education problems.

10. Although a host organization may house an alliance during its start-up, the alliance should become *independent* as soon as possible.

11. *In-kind sharing of resources* such as office space, printing and staff is as essential to a starting alliance as cash contributions. Selling products such as activity-based science kits is a fiscally sound way to support an ongoing program.

12. Alliance builders should meet with broad-based groups and use a three step process, identifying: 1) *trends* (the what?); 2) *implications* (the so what?); and 3) *mission* (the now what?).

13. An alliance should select initial projects that are *doable* and *limited* to ensure success. Communicate positive results externally and internally. Projects should result from identified needs.

14. Effective *communication* between all individuals and organizations is essential to an ongoing productive alliance.

15. An alliance must *assess* and *evaluate* its objectives and programs, making periodic reports on outcomes. Businesses and foundations want quantitative evaluations and teachers and educators want qualitative information as evidence of project success.

16. *Funding* and *contributions* must be tax deductible. This suggests a 501(c)3 nonprofit structure for alliances.

17. An alliance must develop funding so that the corporate community does not carry both its programs and operations *budgets*.

18. *Funders* must be active participants in the alliance, involved in at least an advisory capacity.

19. All programs have to be *revitalized* or the top level advisory staff will lose interest.

20. *Recognition* of accomplishments is important. Give credit and visibility to people and organizations when deserved and only take credit when it is merited.

The preceding principles were developed by working group participants attending alliance building conferences.

APPENDIX 6
EXAMPLES OF ALLIANCE PROGRAMS

Alliances are engaged in a variety of programs and projects to help achieve the goal of upgrading mathematics, science and technology education. These brief descriptions of some of these programs suggest the range and magnitude of these activities.

Volunteer Scientist Programs

Alliances have established volunteer programs such as the Volunteers in Partnership (VIP) program of the Pittsburgh Regional Center for Science Teachers, where local scientists, mathematicians and engineers visit schools, make presentations, act as mentors for the teachers or students, tutor students, conduct laboratory activities with classes, and arrange field trips. For example, the Arizona Alliance for Mathematics, Science and Technology Education has a Rural School Outreach Program which brings scientists from many diverse fields (botany, entomology, aeronautics) to rural elementary classrooms where they make lively presentations, engaging students in hands-on activities.

Workshops for Teachers

Many alliances provide inservice workshops to enrich the science and mathematics background of teachers. These workshops may be of short duration, ranging from a few hours, either after school or on Saturday, to several days or weeks. For example, the Mathematics and Science Center in Virginia offers Teacher Adventures on selected Saturdays. These enrichment programs cover a wide range of topics, such as "Monticello, Math, Science and Architecture" and the "Kites, Hot Air Balloons Workshop." The Science Education Network for the Southeast Alliance in Georgia conducts intensive two-week summer science workshops for teachers of grades K-8.

Summer Fellowships, Institutes, and Internships for Teachers

A large number of alliances provide teachers with summer employment which offers experiences to enrich the teachers' background in the application of mathematics and science in an industry or research setting. Industry Initiatives for Science and Math Education and the Los Angeles Educational Partnership are among the alliances offering such opportunities for teachers. The teachers are paired with mentors in business and industry during the summer and get experience in the application of their discipline in the real world. Staff of the Lawrence Hall of Science assist the teachers in adapting this new knowledge to age-appropriate classroom activities. Many mentor-fellow relationships

are maintained throughout the year and involve the mentor with the teacher's school and students. Friends of Fermilab in Illinois conducts summer institutes for science teachers and provides college credit for participating teachers.

Clearinghouse for Materials

Because large quantities of specialized information are often generated and collected by alliances, some establish clearinghouses for cataloging this information. This is a primary function of the Center for Applied Linguistics in Washington, DC, which operates three clearinghouses for information about the latest developments in language, literacy and bilingual education. A function of the Teachers Clearinghouse for Science and Society Education in New York is to collect and disseminate information worldwide, on programs in the science, technology and society (STS) field.

Resource Directories

Several alliances produce resource directories or use other methods for conveying information about resources to interested teachers. The Coalition for Excellence in Science and Technology in Michigan publishes a directory for teachers of resources in the community The Florida Alliance for Technological Education publishes resource lists on many topics of interest to educators. The Philadelphia Renaissance in Science and Mathematics (part of the PATHS/PRISM alliance) maintains an electronic bulletin board and the Los Angeles Educational Partnership uses TELEventure, a telecommunications network for participants in its programs. The Colorado Alliance for Science has a toll-free telephone hotline for teachers.

Traveling Science Programs

Traveling science shows make up another important activity of alliances. The Mathematics and Science Center in Virginia, the Science Education Network for the Southeast in Georgia and the East Central Illinois Partnership for Excellence in Education have developed interactive, hands-on, portable math/science exhibits which are circulated in the local schools. Others produce science "magic" shows as well as the interactive science exhibits, which "go on the road," traveling from school to school.

Enrichment Programs for Students

Some alliances offer enrichment programs for student in their areas. The Kalamazoo Area Math and Science Center in Michigan offers a rigorous science, mathematics and technology curriculum to academically talented high school students for part of the school day. This program provides opportunities for students to work in a mentor relationship with local scientists, mathematicians and engineers. The Partnership for Progress Bridge Program in Missouri offers a Saturday Academy for high school students. The Hands-On-Science Outreach in Maryland provides an exciting after school science program for elementary school students (K-6). The Texas Alliance for Science, Technology and Mathematics Education has Science Teaching After Regular School, a similar program for elementary students. The Fellows for the Advancement of Mathematics Education in New York, through the Student Volunteer Network, provides opportunities for high school students to teach in elementary schools under the guidance of master mathematics teachers.

Grants to Teachers

In recognition of the fact that teachers are the most knowledge-able about their needs in the classroom and often have creative solutions to meet these needs, some local alliances award grants to teachers to give them the support to actualize their ideas. The Arizona Alliance for Mathematics, Science and Technology Education; the Dayton-Montgomery County Mathematics Collaborative in Ohio; the Philadelphia Renaissance in Science and Mathematics; and the San Francisco Science Collaborative all offer grants to teachers or groups of teachers who wish to develop and test innovative science or mathematics programs.

Propagation of Partnerships and Offspring Organizations

A few alliances play a role in fostering the multiplication of subordinate organizations. Both the Colorado Education Association and the Coalition for Excellence in Science and Technology in Michigan are actively engaged in the promotion of such partnerships between business and education. The Friends of Fermilab alliance in Illinois has spawned two offspring organizations of teachers: Chemistry West and Physics West. The teachers who make up the membership of these organizations meet monthly to share ideas and support one another and produce periodic newsletters.

APPENDIX 7

Reforming U.S. Science, Mathematics and Technology Education: A Chronological Summary of Selected Reports

1. *A Nation at Risk*, National Commission on Excellence in Education, U.S. Department of Education, 1983. (Alerts public to a need for educational reform, makes recommendations.)

2. *Educating Americans for the 21st Century*, National Science Board Commission on Precollege Education in Mathematics, Science and Technology, 1983. (Recommends role for leadership to bring about education reform.)

3. *Technology Education: A Perspective on Implementation*, International Technology Education Association, 1985. (Recommends the establishment of a comprehensive K-12 technology curriculum.)

4. *A Study of the Performance of Black Students at the University of California, Berkeley*, Philip Uri Treisman, 1985. (Suggests methods for improving performance of minorities in higher education.)

5. *Time for Results*, National Governors' Association, August 1986. (Recommends "choice" schools to improve education.)

6. *The Next Wave: a Synopsis of Recent Education Reform Reports*, Education Commission of the States, February 1987.

7. *Opportunities for Strategic Investment in K-12 Science Education*, report by SRI International, May 1987. (Recommends strategies to promote educational change.)

8. *Nurturing Science and Engineering Talent*, the Government University-Industry Roundtable, National Academy of Science, July 1987.

9. *The Role of Science and Technology in Economic Competitiveness*, prepared for the National Science Foundation by the National Conference Board and the National Governors' Association Center for Policy Research and Analysis, September 1987.

10. *Technology: A National Imperative*, Technology Education Advisory Council, 1987. (Presents a "blueprint" for a K-12 technology curriculum.)

11. *Women and Minorities in Science and Engineering*, National Science Foundation, January 1988.

12. *One-Third of a Nation: A Report of the Commission of Minority Participation in Education and American Life*, American Council on Education, Education Commission of the States, May 1988.

13. *The Mathematics Report Card*, Educational Testing Service, June 1988. (A report of mathematics achievement for the past years in the U.S.)

14. *The Science Report Card: Elements of Risk and Recovery*, Educational Testing Service, September 1988. (Report of science achievement for the past years in the U.S.)

15. *Legacy to Tomorrow*, National Science Foundation Directorate for Science and Engineering Education, Division of Research Career Development, Minority Graduate Fellowship Program, November 1988.

16. "NSTA Report," National Science Teachers Association, October/November 1988 and January/February 1989. (Scope and Sequence, a "blueprint" for reform in science education.)

17. *Science for Children, Resources for Teachers*, National Science Resource Center, 1988. (An extensive list of new science curricula for the elementary level.)

18. *Science Education Programs that Work*, U.S. Office of Education, 1988. (Some new science curricula for elementary and secondary level.)

19. *Power On! New Tools for Teaching and Learning*, Office of Technology Assessment, 1988. (Recommends the use of high technology to update and enrich education.)

20. *Changing America: The New Face of Science and Engineering*, Interagency Task Force on Women, Minorities, and the Handicapped in Science and Technology Interim Report, 1988. (Points out the failure of schools to prepare all students adequately for careers in science and technology.)

21. *Science and Engineering Education*, Energy Research Advisory Board, U.S. Department of Energy, 1988.

22. *A World of Differences*, Educational Testing Service, January 1989. (A report of international achievement in science and mathematics for the past years.)

23. "Investing in People: Education," from Building a Better America, President George Bush, February 1989.

24. *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, March 1989. (A "blueprint" for a more effective mathematics curriculum.)

25. *National Council of Teachers of Mathematics: Standards*, March 1989.

26. *A Plan for Action*, a follow-up to *The Present Opportunity in Education*, Triangle Coalition for Science and Technology Education, April 1989.

27. *Meeting the Needs of a Growing Economy: The CORETECH Agenda for the Scientific and Technical Work Force*, Council on Research and Technology (CORETECH), May 1989.

28. *Turning Points: Preparing American Youth for the 21st Century*, Carnegie Council on Adolescent Development, Carnegie Corporation of New York, June 1989. (Alert public to the weakness in the present system. Suggests policies to remedy the situation.)

29. *They're Not in It for the Money: A Study of Science and Mathematics Teacher Retention*, Boyd, S.E. & Crawford, A.R., July 1989.

30. *State-by-State Indicators of Science and Mathematics Education: A Preliminary Report*, Council of Chief State School Officers State Education Assessment Center, October 1989.

31. *Linking for Learning: A New Course for Education*, Congress of the United States, Office of Technology Assessment, November 1989.

32. *Education Policies for National Survival*, American Chemical Society, November 1989.

33. *Changing America: The New Face of Science and Engineering*, final report from the Task Force on Women, Minorities, and the Handicapped in Science and Technology, December 1989. (Makes recommendations for improving education for all students to encourage them to pursue careers in science and engineering.)

34. *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989.

35. *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989.

36. *To Secure Our Future: The Federal Role in Education*, National Center on Education and the Economy, 1989. (Suggests the role of the federal government in educational reform.)

37. *Crossroads in American Education: A Summary of Findings*, National Association for Educational Progress, Nation's Report Card, 1989.

38. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*, National Research Council, National Academy Press, 1989. (A "blueprint" for a more effective mathematics curriculum.)

39. *Science for all Americans*, American Association for the Advancement of Science, 1989. (A "blueprint" for a more effective science curriculum.)

40. *State Education Performance Card*, Sixth Annual Report, 1989.

41. *Made in America: Regaining the Productive Edge*, Dertouzos et al, the MIT Commission on Industrial Productivity, 1989.

42. *Improving Science Education through Local Alliances*, Atkin, J.M. & A., 1989. (Describes the role of the private sector in education reform.)

43. *Results in Education: 1989*, National Governors' Association, 1989.

44. *Getting Started in Science: A Blueprint for Elementary School Science Education*, the National Center for Improving Science Education, 1989.

45. *Education That Works: An Action Plan for the Education of Minorities*, Quality Education for Minorities Project, January 1990.

46. *Tomorrow's Schools*, a report of the Holmes Group, 1990.

47. *Science Framework for California Public Schools*, California Department of Education, 1990.

48. *Elementary School Science for the 90s*, Susan Loucks-Hursley (et al), Association for Supervision and Curriculum Development, 1990.

49. *Professional Standards for Teaching Mathematics*, National Council of Teachers of Mathematics, 1991.

50. *First in the World by the Year 2000*, Federal Coordinating Council for Science, Engineering and Technology, 1991.

51. *America 2000: An Education Strategy*, U.S. Department of Education, 1991.

52. *From Rhetoric to Action: State Progress in Restructuring the Education System*, National Governors' Association, 1991.

53. *Math and Science: It All Adds Up!* The National Association of State Boards of Education, 1991.

This chronological bibliography was compiled by Judy Philippides, Triangle Coalition for Science and Technology Education.

NOTES

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